Factors Impacting the Success of Computerized Preadmission Screening

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Many approaches to controlling costs under managed care rely on the ability to prospectively identify the type or level of service a patient requires at the time of presentation. Although computers may effectively predict these factors, the impact of such a computer system is greatly dependent on its integration into the admission process. Three factors that influence the effectiveness of predictive screening using a computer were identified. They are detection, intervention and compliance. The effect of these factors was then measured in a prospective randomized trial evaluating the effectiveness of computerized preadmission screening for predicting the appropriateness of inpatient care. This paper examines the three factors and their impact on the effectiveness of the system. A mathematical model that relates the factors to the overall effectiveness of computerized preadmission screening is proposed and considered in a more general context.

INTRODUCTION

The shift to managed care is placing increased focus on measuring and managing the utilization of health care resources. Several investigators have pointed to unnecessary utilization of health care resources as a contributing factor to the rising cost of health care.[1,2] Rates of medically unnecessary inpatient admissions have been reported to exceed 20%.[3,4,5] Overutilization in the inpatient setting results from many process factors: inefficient scheduling, administration of unnecessary tests or procedures, unnecessary hospitalization days, misdiagnosis, and care in the inappropriate setting[6]

With few exceptions, the detection of overutilization is based primarily on retrospective review of care. Ideally, potential overutilization should be identified before it occurs so that intervention can be taken before the resources are used. Requiring precertification for selected procedures and empowering primary care physicians as gatekeepers represent two efforts to address overutilization prospectively. A third approach to prevent overutilization that is targeted at inpatient care is preadmission screening. Preadmission screening has been used by commercial payers for at least ten years in order to reduce overutilization.[7,8,9] Computerization of the preadmission screening process offers the potential for timely identification of overutilization.

We implemented a computerized screening program using a commercial expert system. A randomized study was conducted to measure the ability of this computerized screening tool to identify unnecessary inpatient admissions.[10] As part of the study, we measured the impact of detection by the expert system, intervention by the reviewer and compliance of the admitting physician on the effectiveness of the screening program. This paper presents a method for estimating the potential effect of a preadmission screening application.

METHODS

Setting

The study was performed at LDS Hospital in Salt Lake City, Utah, a 520 bed tertiary care facility and home of the HELP hospital information system.[11] HELP collects and manages a wide breadth of clinical information including: laboratory and blood bank data from clinical information systems, vital signs from bedside monitoring devices, and nursing notes from bedside terminals. HELP runs on a TANDEM mainframe computer and stores the clinical data in a centralized patient database.[12]

We integrated a stand alone personal computer-based expert system with the HELP hospital information system. The expert system, *Review Criteria* (Code 3/HSI, Murray, UT), is a commercial program that evaluates the appropriateness of inpatient admissions. *Review Criteria* implements the appropriateness guidelines used by the Utah Peer Review Organization (UPRO), known as Appropriateness Evaluation Protocol (AEP). We focused on identifying unnecessary inpatient admissions resulting from admitting a patient for treatment as an inpatient when the level of care required (as determined by payor reimbursement criteria) did not warrant hospitalization.

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Computerized Preadmission Screening Process

HELP and *Review Criteria* worked together in the following manner.[13] HELP detected admission events (scheduling of an admission or entry of a nonscheduled admission) and managed a work list of cases awaiting review. A Utilization Management (UM) Nurse began a preadmission review by selecting a patient from the HELP patient census list. A HELP program passed demographic information to *Review Criteria* and invoked the expert system. The UM Nurse then answered questions prompted by *Review Criteria*. On completion of the review, *Review Criteria* passed the prescreening results back to HELP. These results included the ICD-9-CM codes for the proposed admission diagnosis and anticipated procedures, a prospective DRG classification and an assessment of appropriateness of inpatient hospitalization. The UM Nurse used information from the integrated HELP/*Review Criteria* system to determine the appropriateness of the patient's admission. These reviews were conducted prior to admission, for scheduled admissions, or within the first 24 hours following admission for nonscheduled admissions.

In the event the expert system determined that an admission was unnecessary, the UM Nurse contacted the admitting physician and suggested alternatives to inpatient admission. Based on the expert system's recommendation and with physician's approval, the patients were redirected to a more appropriate care setting, such as outpatient, interim care or short stay care areas.

Evaluation of Screening System Effectiveness

To evaluate the effectiveness of the computerized preadmission screening system, we conducted a randomized trial involving all Medicare admissions for a 20 week period. In half of the reviews (the experimental arm), if the inpatient admission appeared to be unnecessary, the UM Nurse contacted the physician as described above. In the other half of the reviews (the control arm), the outcome of the expert system review was not acted upon by the UM Nurse. The rate of unnecessary inpatient admissions for each group was determined by selective, post discharge reviews conducted independently by the Health Information Services (formerly Medical Records) Department. These reviews, which represented the gold standard, were performed manually (without the expert system) using the same criteria encoded in the expert system. (The post discharge review served as an indirect measure of payment denials resulting from unnecessary admissions. The details of this indirect measure and its correlation to actual denials are explained more fully elsewhere.[10])

As part of the study, we evaluated three factors for their potential impact on the overall screening system. We labeled the factors detection, intervention, and compliance. We defined *detection* as the proportion of cases determined by post discharge review to be unnecessary (or potentially unnecessary) inpatient admissions that were correctly identified by the preadmission screening process. This is equivalent to the sensitivity of the computerized screening system. We defined *intervention* as the act of the review nurse contacting the admitting physician and suggesting a change in the physician's admission plan based on the recommendation of the computerized screening system. Intervention is represented numerically by the proportion of cases that were found by computerized screening to be unnecessary admissions and for which the physician was contacted in a timely fashion. *Compliance* was defined as the proportion of all cases in which a physician was contacted and changed the patient's admission type as a result of review nurse's recommendation.

Detection, intervention and compliance were measured prospectively according to the above definitions. Additional analyses were performed to validate the performance of the expert system. The results of these additional analyses are not considered in detail here.[10]

Relationship of Screening Factors

Because of the interrelatedness of the three factors: detection, intervention and compliance, we combined them in a straight forward multiplicative relationship to estimate the magnitude of effect of preadmission screening on reducing unnecessary admissions. We named this product ω because of its similarity to

$$\omega = d \cdot i \cdot c \qquad (1)$$

omega-squared (ω^2), a relative measure of the magnitude of effect of an experimental intervention. Equation (1) shows the algebraic relationship of the factors where ω is the overall magnitude of effect, **d** is the rate of detection, **i** is the rate of intervention, and **c** is rate of compliance. As each term is represented by a percent rate, the product of the terms will never be more than 1.0. We theorized that the rates could be combined in this manner because compliance only

has meaning as a rate of those cases in which the UM Nurse successfully intervenes. Also, intervention similarly only has meaning as a rate of those cases which are identified or detected by the expert system. The equation reflects the fact that, to the degree that any factor is less than perfect (1.0), the factor reduces the overall effectiveness of the system.

For example, if 100% of unnecessary inpatient admissions could be detected and in 90% of those cases the preadmission nurse was able to intervene, but only 50% of the physicians contacted accepted the recommendation, then one could only expect to see a reduction in unnecessary admissions of 45% (1.0 * 0.9 * 0.5 = 0.45). The value for ω was calculated from the values of **d**, **i**, and **c** measured in the experiment. This ω was compared to the observed effect of the overall system as determined by the difference in unnecessary hospitalization rates between the control and experimental groups.

RESULTS

Over a six month period in 1991 two preadmission nurses reviewed 1971 inpatient admissions and scheduled admissions.

Component Factors

Detection. The retrospective review of cases established an overall detection rate (sensitivity) of the system at 46% (34/74). At the same time, the system had a high level of specificity (ability to distinguish those requiring inpatient hospitalization) of 95% (1826/1897). (Note: results of the experimental and control arms were pooled in the above calculations since, as noted below, no significant difference was found between the two arms of the experiment.)

Intervention. In the experimental group, 44 cases were identified by the expert system as potentially unnecessary admissions. In 14 of the 44 cases (31.8%) the nurse was able to contact the physician before admission or within the first 24 hours following unscheduled admissions.

Compliance. Physicians complied with the review recommendation in 78.6% (11/14) of the cases.

Overall Performance

The final retrospective review conducted by the Health Information Services Department found 3.6% (36/992) of inpatient admissions in the experimental group were unnecessary and 3.9% (38/979) in the control group were unnecessary. Criteria for unnecessary admissions were empirically derived by the Health Information Services Department based on UPRO guidelines and historical payment denials. The difference of the rates represents a 6.5% decrease in the experimental group. The result of a test of the difference of proportions is not statistically significant ($p > 0.43$).

Equation (2) shows the substitution of the measured rates for the various factors from our experimental

$$\omega = 0.46 \cdot 0.32 \cdot 0.79 = 0.116 \qquad (2)$$

results. Based on the observed rates of detection, intervention and compliance, the calculation for ω shows that the magnitude of change we should have observed was 11.6% in the rate of unnecessary inpatient hospitalizations. Applying ω to the measured rate in the control group (3.9%) would have lead to a hypothetical rate of 3.4% in the experimental group. The difference between the measured percentage change (11.6%) and the hypothetical rate of change (6.5%) was not statistically significant.

DISCUSSION

We have presented a model that incorporates the major factors that influence the performance of a preadmission screening system. This model arose from an experiment in which we failed to demonstrate a significant reduction in inappropriate inpatient admissions using computerized preadmission screening. In retrospect, the model serves to identify the factors that lead to our inability to reduce inappropriate admissions.

While we hesitate to draw conclusions about the effectiveness of preadmission screening at other institutions, our data suggest a number of cautions in the use of preadmission screening. First, the success of preadmission screening results from a number of factors, not just the ability to predict unnecessary hospitalizations. Second, successful intervention requires real-time review and action. Finally, the proposed model for ω may be applicable to other types of screening that might be applied to reduce overutilization, particularly in a managed care setting. The components of the proposed model fit a pattern for many screening activities. In other settings, the

component parts may have different effects, but similar, diminutive results.

Overall Effect

Of principal interest among the results is the confirmation of the overall effect (ω) of the preadmission screening system by the proposed model of component effects. The model we have proposed shows that no single factor can be less effective than the expected overall performance of the system. Since all factors range from 0 to 1.0, if any individual factor is less than the desired ω, the other factors cannot sufficiently compensate to improve the overall performance of the system. In our case this meant that even if we could mandate compliance and could make whatever changes necessary to improve intervention, we were limited by the performance of our detection tool to reducing the rate of unnecessary admissions by only about 45%.

Because the computerized preadmission screening system did not result in a statistically significant change in potentially unnecessary inpatient admissions, it is important to consider in greater detail the factors that, according to our model, contributed to the system performance.

Detection

Detection was defined as the ability of the expert system to identify prospectively those patients that retrospectively would be determined to have been unnecessarily admitted as inpatients. The low rate of detection suggests the expert system was not so "expert." However, the screening criteria used by *Review Criteria* are well studied and considered quite reliable.[5] As previously noted, the screening criteria used in *Review Criteria* are based on the AEP which comprise 11 criteria measuring severity of illness and 7 criteria measuring intensity of service required for inpatient admission.[4] Additionally, a preliminary study using *Review Criteria* suggested that an 80% detection rate was possible. Because the expert system was taken as an off-the-shelf unit, verification of *Review Criteria* was not a focus of the study. Followup studies reported in detail elsewhere[10] showed the system performs at least as well as humans.

The low level of detection has broader implications as a component of ω. Although expert systems with better predictive ability may be found, in order for the system to be used, it must be integrated into the overall flow of the admissions process. The proposed model for ω shows that other factors will erode the effect of even a highly predictive expert system.

Intervention

Intervention was defined as the UM Nurse's contact of the physician in a timely fashion to change the patient's admission from inpatient to outpatient. As a component factor, intervention was measured at 0.32 or 32% and was the lowest of the three factors.

Further examination revealed that timeliness of reviews was a primary reason for the low rate of intervention. We found a statistically significant correlation between missed interventions, unscheduled admissions and short lengths of stay (one day or less). Not only did unscheduled admissions not permit true preadmission review (i.e., before admission), we also measured what we had long suspected: when compared to scheduled admissions, unscheduled presentations for admission had a significantly higher rate of unnecessary inpatient admissions.

These data suggested that a real time process is essential for successful preadmission screening. Successful intervention requires all reviews be conducted within a narrow window of time as soon as a patient is scheduled for admission or presents for admission. Woerly[14] suggests a comprehensive program for implementing effective screening and intervention. Although the computer system was implemented to support real-time review, accomplishing this at our site required a new level of cooperation between registration and utilization review that was not possible at the time of the study. As a result, reviews were placed in an electronic queue and conducted in a batch mode, usually once a day.

Compliance

Because we defined intervention as the UM Nurse's recommendation to the physician to change the admission type, MD compliance to the recommendations was measured separately. Compliance was the proportion of physicians who were informed that their patient did not meet criteria for inpatient hospitalization and adjusted their admission plan accordingly over the total number of physicians informed. The response rate of 78.6% was consistent with our expectations for this application based upon the literature.[9,15] However, physician compliance in many other settings is much lower. We attribute the high rate to the perceived financial incentive to comply. Unnecessary admissions were linked to potential reimbursement denials.

One factor that was not considered in Equation 1 is the rate of inappropriate inpatient hospitalizations. This rate could significantly impact the ability to measure an effect from preadmission screening. A low level of inappropriate admissions makes it difficult to validate any system that screens for admission inappropriateness or to see measurable results in a reasonable length of time. As noted, the literature suggests rates of inappropriate admissions in excess of 20%. We estimated the rate of inappropriate admissions at our facility is much lower than this, between 5% and 10%. Pilot work that preceded this study showed the overall rate of inappropriateness was on the increase, from 3.0% in 1988 to 10.6% in 1989. However, during the period of this study, the rate dropped to a 2-year low of 3.8%. At least one other investigator[16] has observed and noted similarly low levels of inappropriate admissions at a large tertiary care center. A sample size of 30,000 would have been required to measure a significant change at the hypothetical level for ω of 11.6%.

Institutions that hope to reduce unnecessary or overutilization through preadmission screening should have a clear idea of how they intend to predict and measure prospective inappropriate utilization. Additionally, before implementing a system (computerized or manual), an institution should not only know the level of inappropriate utilization that presently exists, but also have an idea of how much inappropriate utilization they expect a preadmission screening program may be able to eliminate.

We believe there is potential to improve the preadmission classification of patients by assigning them to the appropriate level of care and consequently reduce overutilization. However, we caution that reducing 100% of overutilization is problematic and difficult to measure. We look forward to the development of more sophisticated tools and methods to be applied to the issues reimbursement classification and medical necessity.

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